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Study of physico-chemical parameters of three different urban pond water of Nadia district, West-Bengal, India

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Abstract
The present study was carried out to make a comparative ecological assessment of three urban ponds of Nabadwip at Nadia district, West-Bengal. The average value of water temperature in P-1, P-2 and P-3 ponds were 29.6, 30.0 and 29.8°C respectively, average value of water pH was the highest in the P-2 (7.33). The maximum average DO value was found in P-2 (5.67 mg l^{-1}), average value of free CO_2 was maximum in the P-3 (38.07 mg l^{-1}). The highest value of alkalinity was found in P-3 (315 mg l^{-1}). The maximum concentration of BOD and COD were recorded in P-3 accordingly (3.08 mg l^{-1}) and (75.17 mg l^{-1}). The highest average value of Phosphate-phosphorous was recorded in P-2 (0.24 mg l^{-1}) and the Nitrate-nitrogen concentration was recorded maximum in P-3 (1.48 mg l^{-1}). The present finding established that, the well managed pond (P-2) showed better ecological conditions compare to unmanaged ponds.

Keywords: Water characteristic, seasonal variation, urban ponds, management practices, Nabadwip

1. Introduction
Ponds are important part of urban ecosystem. Though relatively small in size, ponds perform significant environmental, social and economic functions, ranging from being a source of drinking water, recharging groundwater, acting as sponges to control flooding, supporting biodiversity and providing livelihoods. Ponds have been used since time immemorial as a traditional source of water supply in India. However, the water of the ponds, lakes and river are polluted mainly due to discharged waste water from residential areas, sewage outlets, solid wastes, detergents, automobile oil wastes, fishing facilities and agricultural pesticides from farmlands (Hasan *et al*.,) [16]. Water is one of the most abundant compounds in earth approximately covering three-fourth of the earth's surface. Majority of water available on earth is saline in nature; only a small quantity exists as fresh water. Fresh water has become a scarce commodity due to over exploitation and pollution (Basavaraja Simpi *et al.*,) [8]. Day by day water is becoming more and more unfit to mankind due to unwise use, neglect and mismanagement. Many of the physical and chemical properties of water must be considered in its management. Some of these properties are temperature, pH, hardness, dissolved oxygen, source of the water in the pond, uses made of the water, and where it goes if it flows from the pond. The characteristics of water bodies are influenced by seasonal variations. A good knowledge of the chemical qualities of raw water is necessary so as to guide its suitability for use. The study of different physico-chemical parameters is very important for understanding the metabolic events in aquatic ecosystem. The parameters influence each other and govern the distribution and abundance of flora and fauna (Shinde *et al.*,) [29]. Many authors have already studied in several areas in Nadia district, West-Bengal. Kumar (1985) [21] reported water quality characteristics in beel, Bala and Mukherjee (2011) [6] also studied water quality parameters of sixty wetlands, Das *et al.,* [11] recorded physico-chemical parameters of three reservoirs, Bhaumik *et al.,* [7] also observed physico-chemical parameters of two beels. But, there were no such studies from this region and therefore a study of some physico-chemical parameters was undertaken in different ponds from Nabadwip municipal areas to check the pond water quality with different management practices of these urban ponds.

2. Materials and Methods

The present study was carried out for a period of six months from January 2017 to June 2017. Three ponds with different management practices were selected to make a comparative ecological study among them. The water bodies identified for the present study are situated within the municipal boundary of Nabadwip, West Bengal. First pond (P-1), Station Road Pond moderately managed is situated near Nabadwip railway station with around 7000 m^2 area and surrounded by cemented wall. Second pond (P-2), situated at Tegharipara, an earthen well managed pond with 6500 m^2 area. The third pond (P-3), namely Gobinda Dighi pond is situated near Royal club, highly unmanaged with 5600 m^2 area. The water samples were collected fortnightly in the early morning (between 7.30 am to 9.30 am) from each pond. The variations in water parameters such as temperatures, pH, dissolved oxygen, free carbon dioxide, total alkalinity, biological oxygen demand (BOD), chemical oxygen demand (COD), phosphate-phosphorous and nitrate nitrogen were estimated following standard methods (APHA,) [4]. General features of the three ponds were provided in the Table 1.

Table 1: General features of three studied ponds under urban Nadia.

Features	P-1	P-2	P-3
Area (m^2)	7000	6500	5600
Average Depth (m)	5-6	6-7	3-4
Type of water body	Perennial	Perennial	Perennial
Source of water	Rain fed, water seepage and surface run off	Rain fed, water seepage and surface run off	Rain fed, water seepage and surface run off
Purpose of use	Domestic purposes, washing, bathing, idol immersion etc.	Bathing without soap, cooking. Vehicle washing and idol immersion not allowed.	Bathing, washing, dumping, domestic purpose, idol immersion etc.
Management status	Moderately managed, concrete dyke, fish culture practices.	Well managed, regular cleaning and monitoring, natural earthen dyke, fish culture practices.	Unmanaged, no proper cleaning and monitoring, no such type of fish culture.

3. Results and Discussions

3.1 Temperature: The average water temperature of P-1, P-2 and P-3 pond was found to be 29.62, 30.08 and 32.41˚C. The water temperature was found suitable for fish growth due to standing water and relatively small size of those water bodies. According to Welch (1952) [36] smaller the body of water, more quickly it reacts to changes in the atmospheric temperature. This is particularly true for shallow lakes and ponds like in present study (Efford,) [14]. Singh *et al.*, [30] also reported similar kind of limnological parameters in wetlands of 24 south Parganas district of West Bengal.

3.2 Water pH: The average water pH was 7.23, 7.33 and 7.32 in P-1, P-2 and P-3 ponds respectively. The magnitude of fluctuation of pH depends on buffering capacity (total alkalinity of water) and rates of photosynthesis, respiration (Boyd) [10]. Soni and Bhatt [32] while studying the ecology of an urban pond near Vadodara, Gujarat found an average pH of 7.15 during summer months and 8.3 during monsoon season. The results obtained during the present study are somewhat similar to the above findings. On all the occasion the pH values were above 7.0 except during June in P-1 pond (6.8) and in P-3 pond (6.9).

3.3 Dissolved Oxygen: The average DO concentration in the water body P-1, P-2 and P-3 were 4.03, 5.67 and 3.55 mg l^{-1} respectively. At P-1 pond the DO varied from 3.1 to 5.9 mg l^{-1}, in P-2 pond between 4.2 to 7.46 mg l^{-1} and in P-3 pond it varied between 2.1 to 8.0 mg l^{-1}. The DO is said to be utilized by microorganisms during decomposition process of organic matter. As P-3 pond is open to all kind of protuberances and an interference including dumping of wastes from nearby areas, the DO might have been utilized by microorganisms towards degradation of the high organic load (Bhatt *et al.*,) [9] thus leading to decrease in DO concentration in the water body. As the P-2 pond is better managed water body compared to others, hence, normal range of DO was found. Nath and Tripathi [26] reported dissolved oxygen values in fish ponds of Hanspukur, Malda, Burdwan and Jaipaiguri regions of West Bengal respectively as 4.8-9.2, 4.1-9.2, 3.7-8.4 and 4.5-9.02 mg l^{-1}.

3.4 Free carbon-dioxide: In P-3 pond the average free carbon-dioxide value was 38.07 mg l^{-1} which was significantly higher than P-1 pond (27.23 mg l^{-1}) and P-2 pond (14.82 mg l^{-1}). Carbon-dioxide is subjected to wide fluctuations because of its capacity to combine to Ca, Mg and other elements, its utilization during photosynthetic process and release during respiration of organisms and decomposition of organic matter. According to Goel and Trivedi [15], the increase in organic matter results in high biological and chemical demands, decreasing the DO levels and consequently increasing the free carbon-dioxide. Das [10] while assessing the ecology of a flood-plain wetland of Kalyani, an industrial area of WB, found the maximum CO_2 to be 40 mg l^{-1}. Das and Chand [12] reported similar observations in a community pond in Ganjam district in Orissa. On an average the P-2 pond had the least average free carbon-dioxide level (14.82 mg l^{-1}). This may be due to lesser interventions by outside or nearby people and lesser pollution load.

3.5 Total Alkalinity: Alkalinity in most natural water is the function of bi-carbonate and carbonates. Their salt gate hydrolyzed in solution and produced hydroxyl ions. It is also used as a measure of productivity (Hulyal and Kaliwal) [17]. In P-3 pond the average alkalinity value was 315 mg l^{-1}, which was significantly higher than P-2 pond (145.93 mg l^{-1}) and P-1 pond (226.34 mg l^{-1}).The alkalinity was high during the summer seasons. The month of April showed the highest alkalinity (273±32.52 mg l^{-1}) and (355±1.41 mg l^{-1}) in both P-1 and P-3 pond respectively. It may be due to the concentration of nutrients in water. Adebisi [3] showed alkalinity to be inversely correlated with the water level. The results obtained from the present study were close conformity with the findings of Mishra *et al*., [23] and Arya *et al*. [5]

3.6 Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD): Biological Oxygen Demand gives an idea of the quantity of bio degradable organic present in an aquatic system, which is subjected to aerobic decomposition by microorganisms. Chemical Oxygen Demand is the measure of the oxygen equivalent of the organic matter contained of the water i.e., necessary for oxidation by a strong chemical oxidant (APHA) [4]. These are the reliable parameters for judging the extent of pollution in water (Mishra and Saksena [24] and Singh *et al.*,) [31]. In the present study the average value of BOD was 3.08 mg l^{-1} in P-3 which was significantly higher than P-1 (0.96 mg l^{-1}) and P-2 (1.13 mg l^{-1}). Varghese and Naik [31] observed an average BOD value of 3.8 mg l^{-1} while conducting the hydro biological study of a domestically polluted water body. The average COD values in the water body P-1, P-2 and P-3 were 56.85, 58.43 & 75.71 mg l^{-1} respectively. The highest concentration of BOD and COD in P-3 may be due to the establishment of human colonies, markets at the bank of the pond which are responsible for adding domestic sewage (Mohan *et al.*, [25] and Sharma *et al.*, [28]). This study also revealed a higher value of COD with respect to BOD in all three water bodies, which was in agreement with Zanoni [37] who reported that the COD values higher than BOD when organic matter contains a large amount of biological resistant substance. The BOD of unpolluted water is less than 1.00 mg l^{-1}, moderately polluted water 2.00 to 9.00 mg l^{-1} while heavily polluted water has BOD more than 10.00 mg l^{-1} (Adakole) [2]. The BOD in different months in P-3 fluctuated between 0.9 and 6.2 mg l^{-1} indicating the pond status as moderately polluted. The status of other two ponds is unpolluted.

3.7 Phosphate Phosphorus: Phosphorus is always available in the forms of phosphate in natural waters and is considered as one of the limiting nutrient causing eutrophication leading to extensive algal growth. The higher concentration of phosphorus is indicative of pollution (Mishra and Saksena,) [24]. The phosphate concentration above 0.5 mg l^{-1} indicates pollution (Jain *et al.*,) [19]. The average phosphate phosphorus concentration in the water body P-1, P-2 and P-3 was 0.23, 0.24 and 0.18 mg l^{-1} respectively. The lower values of these nutrients in water phase may be due to the reason that large amount of nutrients are accumulated and locked by macrophytes and thus removed from the circulation (Acharjee *et al.*,) [1].

3.8 Nitrate-Nitrogen: In the present study the average nitrate-nitrogen concentration in the water body P-1, P-2 and P-3 were 1.28, 1.46 and 1.48 mg l^{-1} respectively. Nitrate value was higher in winter and lower in summer in all three ponds under study. Hutchinson [15] observed similar trend and suggested that in summer denitrifying bacteria break up nitrates into nitrites and ammonia. In winter, however, the activities of these bacteria goes down (Kaur *et al.*,) [20] resulting the higher value in winter in these two water bodied P-2 and P-3. Kumar and Bohra [22] also pointed out the higher concentrations of nitrate due to entry of pollutants.

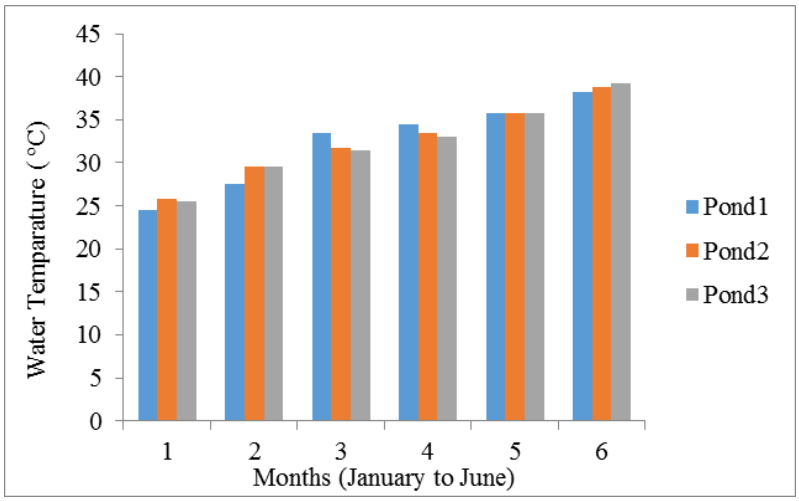

Fig 1: The monthly mean variation in water pH

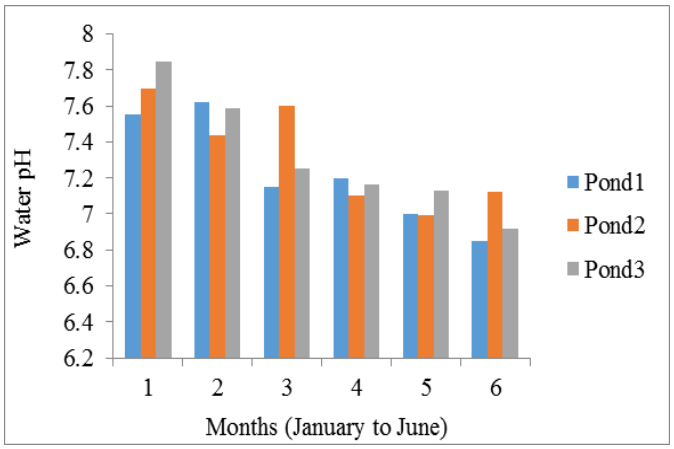

Fig 2: The monthly mean variation in water Temperature

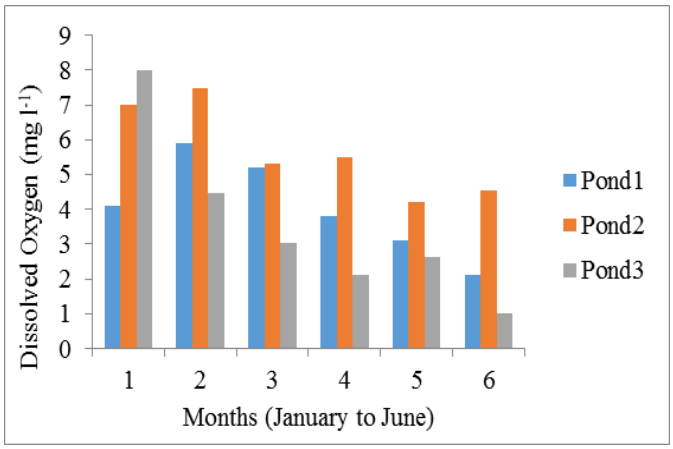

Fig 3: The monthly mean variations in water DO water

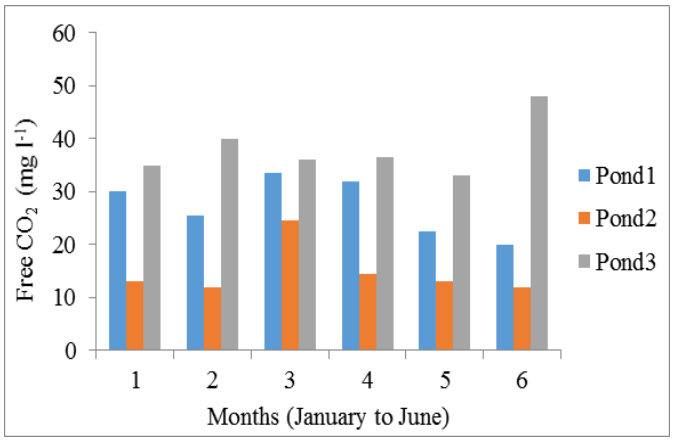

Fig 4: The monthly mean variation in free carbon dioxide

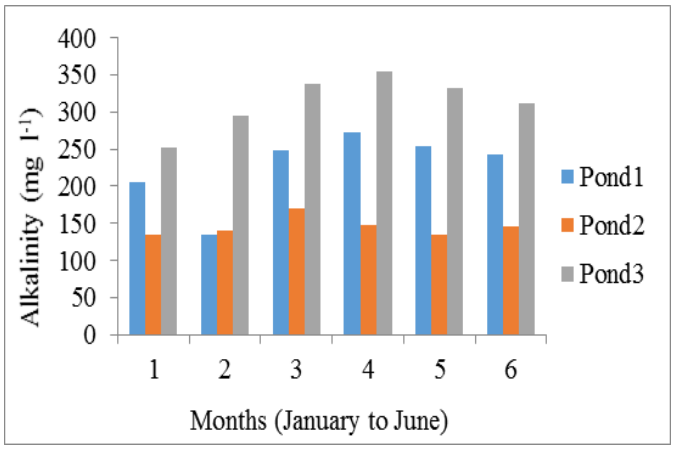

Fig 5: The monthly mean variation in water water Alkalinity

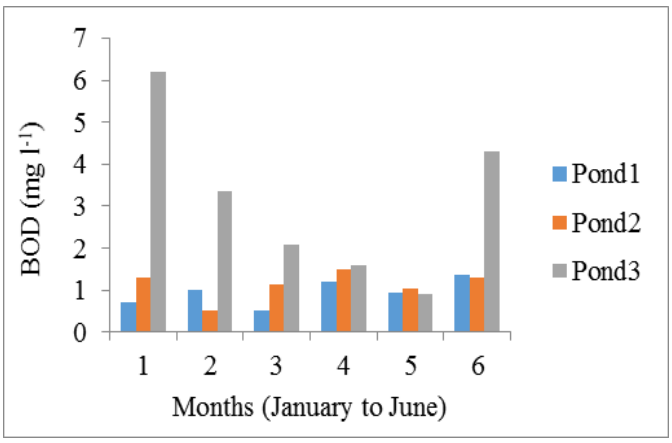

Fig 6: The monthly mean variation in BOD

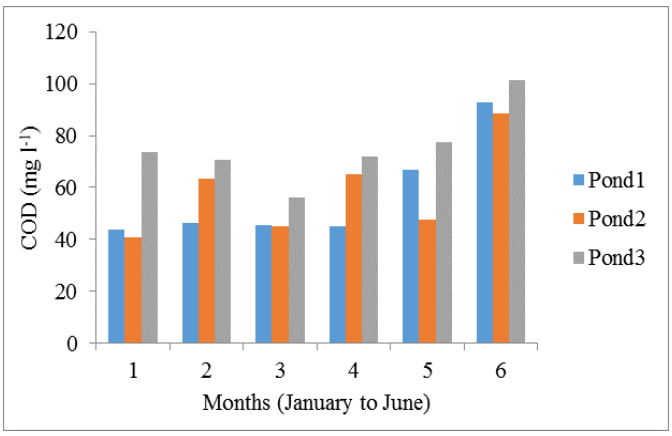

Fig 7: The monthly mean variation in water COD water

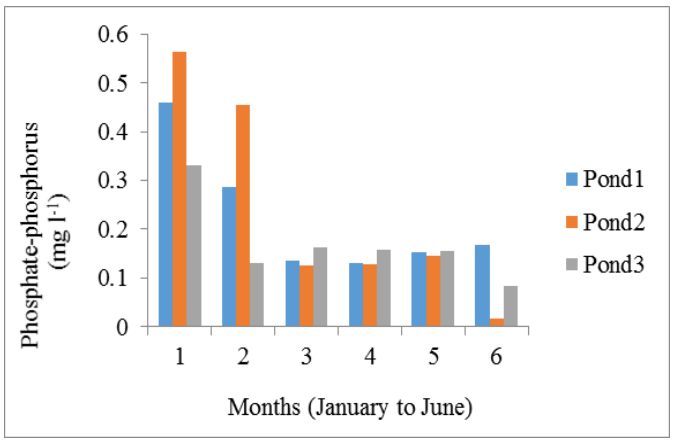

Fig 8: The monthly mean variation in phosphate phosphorus

4. Conclusion

In the light of present findings it can be inferred that there is a clear cut differences in the physico-chemical parameters of experimental water bodies. Most of the water quality parameters including water pH, Free CO_2, Alkalinity, Phosphate Phosphorus, Nitrate-Nitrogen, COD, were highest in P-3 and lowest value of DO and BOD was also recorded in P-3. So, from the overall study, it can be concluded that the health status of P-3 is significantly inferior. The reason may be due to high level of anthropogenic activity and poor maintenance of this water body. After studying all the parameters, it can be concluded that the ecological condition of P-2 is better than P-1. The reason may be due to the better management practices like no idol immersion, no washing of utensils, clothes and vehicles etc. by the society's people.

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